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(71) Applicant: **PITNEY BOWES, INC.**
World Headquarters
Stamford Connecticut 06926-0700(US)

(72) Inventor: **Digiulio, Peter C.**
112 Morehouse Street
Bridgeport, CT 06605(US)
Inventor: **Bergman, Norman J.**
17 Ole Musket Lane
Danbury, CT 06810(US)
Inventor: **Ramirez, Frank D.**
60 Lawn Avenue No.24
Stamford, CT 06902(US)
Inventor: **Salazar, Edilberto I.**
116 Pocono Road
Brookfield, CT 06804(US)

(74) Representative: **Cook, Anthony John et al**
D. YOUNG & CO. 10, Staple Inn
London, WC1V 7RD(GB)

(54) **Microprocessor system controller for mail processing system applications.**

(57) The motor controller system controls the respective motors of a plurality of cooperative apparatus associated with a article processing system, the article processing system for performing a plurality of functions upon an article traversing the article processing system and comprises a motor driver board having a plurality of input channels and a plurality of respective output channels. The motors are in line communication with a respective one of the output channels of the motor driver board. A programmable microprocessor is in bus communication with the driver board's input channels. A plurality of sensors are respectively mounted to each of the apparatus and in bus communication with the programmable microprocessor, the sensors being strategically located on the apparatus to provide such information to the microprocessor as article size, position and velocity information and to provide apparatus operation information. The microprocessor is programmed such that a cycle is preformed at a desired frequency, each control cycle being divided into discreet time intervals during which respective time interval the microprocessor transmit motor control command information to the driver board for respective motors and during other of the time intervals the microprocessor reading information from the sensors.

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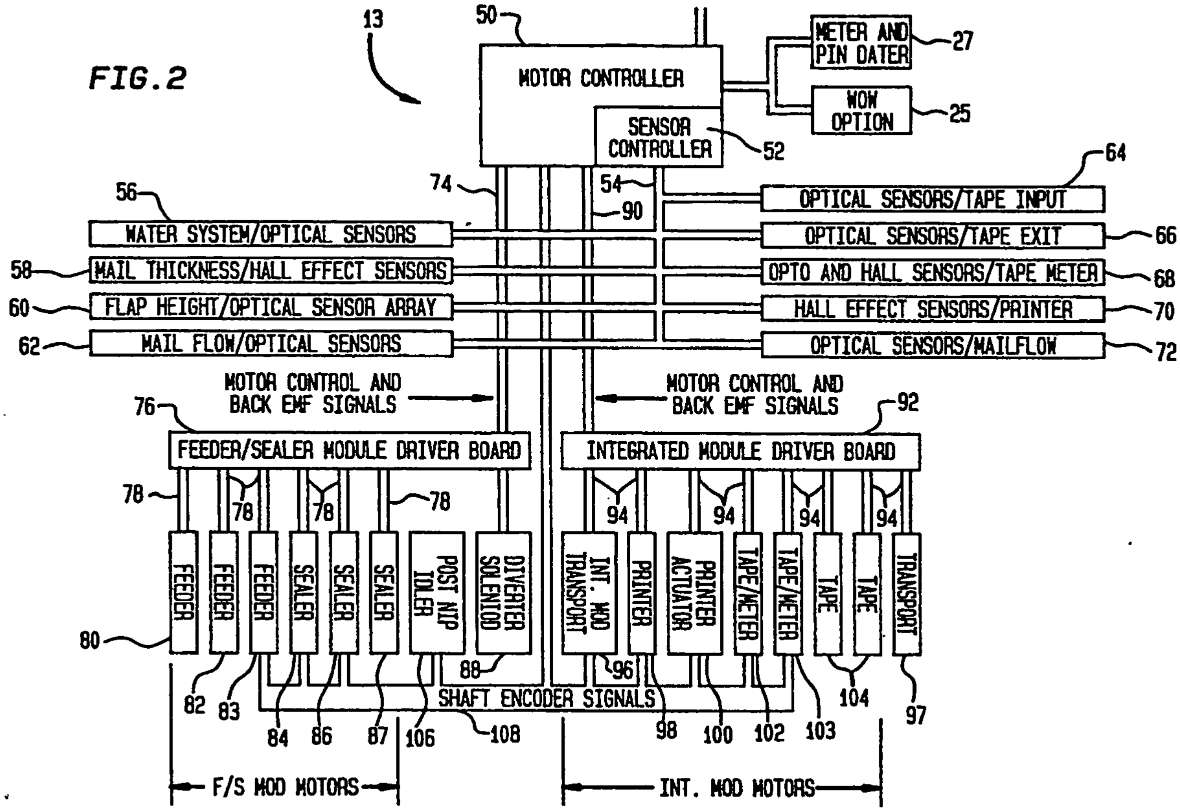
FIG. 2


13
50
MOTOR CONTROLLER
SENSOR CONTROLLER
52
METER AND PIN DATER
27
WOW OPTION
25
64
OPTICAL SENSORS/TAPE INPUT
OPTICAL SENSORS/TAPE EXIT
66
OPTO AND HALL SENSORS/TAPE METER
68
HALL EFFECT SENSORS/PRINTER
70
OPTICAL SENSORS/MAILFLOW
72
56
WATER SYSTEM/OPTICAL SENSORS
58
MAIL THICKNESS/HALL EFFECT SENSORS
60
FLAP HEIGHT/OPTICAL SENSOR ARRAY
62
MAIL FLOW/OPTICAL SENSORS
74
54
90
MOTOR CONTROL AND BACK EMF SIGNALS
MOTOR CONTROL AND BACK EMF SIGNALS
76
FEEDER/SEALER MODULE DRIVER BOARD
92
INTEGRATED MODULE DRIVER BOARD
78
94
FEEDER
FEEDER
FEEDER
SEALER
SEALER
SEALER
POST NIP IDLER
DIVERTER SOLENIOD
INT. MOD TRANSPORT
PRINTER
PRINTER ACTUATOR
TAPE/METER
TAPE/METER
TAPE
TAPE
TRANSPORT
80
82
83
84
86
87
106
88
96
108
SHAFT ENCODER SIGNALS
98
100
102
103
104
97
F/S MOD MOTORS
INT. MOD MOTORS

MICROPROCESSOR SYSTEM CONTROLLER FOR MAIL PROCESSING SYSTEM APPLICATIONS

This invention relates to microprocessor controller systems and, more particularly, to such controller systems as may be employed in the control of real-time machine operations such as mail piece processing.

It is known to use a microprocessor controller for the real-time control of certain machine operations. However, such controllers have not been fully satisfactory when employed as an over-all system controller for real-time machine operations in such machine environments where a plurality of machine subsystems function in a high speed synchronous and inter-dependent manner.

For example, a mail processing system may be comprised of an envelope feeder mechanism for receiving a stack of envelopes and, in a seriatim manner, serving up the envelope to a sealer-transport mechanism. The sealer-transport mechanism is charged with the function of sealing each envelope as it is caused to traverse a sealing apparatus and to serve-up the envelope to a mailing machine. It is also known to employ a scale mechanism interposed between the sealer-transport mechanism and the mailing machine. The scale mechanism is charged with the function of weighing the envelope by means of a scale, and determining the required postage value and communicating the postage value to a postage met r. In similar manner, a transport mechanism, customarily integral to the scale mechanism, must assume physical control over the envelope for positioning the envelope on the scale and thereafter serve-up the envelope to the mailing machine.

Generally, the mailing machine will include a transport mechanism which assumes control over the envelope and delivers the envelope to a printing station whereupon a postage meter will print a postage indicia on the envelope. The mailing machine transport mechanism will again assume control over the envelope and eject the envelope from the mailing machine.

As aforenoted, in the aforedescribed mail processing system, envelopes are processed in a seriatim manner. In such mail processing systems, it is known to provide each of the cited mechanisms with a motor or plurality of motors to act as prime movers for the associated mechanisms. As is known, each motor or group of motors is under the control of a microprocessor motor controller acting through respective driver boards. It is further known to provide a plurality of sensors associated with the respective mechanisms for providing input information to the respective motor controllers. The motor controllers are programmed to function independently of the other motor controllers. That is, there is a minimum of inter-controller communication generally restricted to "trip" and output speed information.

Synchronization can be achieved through the use of trip information and/or envelope speed information communicated between the several motor controllers. For example, the mailing machine transport motor controller upon receiving a trip signal and existing speed information from the preceeding process station, e.g. a scale, can initiate a countdown to arrival of the envelope from the proceeding station. Furth r, the mailing machine transport motor controller can initiate transport speed adjustment to match the speed of the incoming envelope.

Such mail processing systems as aforedescribed have required the use of multiple microprocessor motor controllers, each of which controllers must be programmed. The programming of each controller is generally dependent on the hardware configuration of the mail processing system. Changes in the hardware configuration, such as, the addition of a scale, generally require program changes to the downstream controllers.

The present invention aims to present a motor controller system having an architecture such that a single motor controller can control the real-time operation of a plurality of motors. Further aims of the present invention are:- to present a means of managing motor controller loading facilitating to the use of a single motor controller to control a plurality of motors; to present a motor controller system whereby the motors under the influence of the motor controller are required to operate in a synchronous manner; to present a motor controller system whereby the motors under the influence of the motor controller are subject to varying controlled velocity profiles; to present a motor controller system which in addition can perform other background control operations; and to present a motor controller system which prioritizes the control of certain control and background functions.

The motor controller system particularly disclosed herein is comprised of a microprocessor motor controller and a microprocessor sensor controller in dir ct parallel communication and is configured for particular suitability for employment in a mail processing system. A first and second board are in independent bus communication with the motor controller. Each driver board is in independent bus communication with a plurality of motors, some of which are servo motors. The respective motors or a group of motors are associated with a particular mail process system mechanism. Each system mechanism has associated therewith a plurality of sensors for supplying input to the motor controller through the sensor

controller. Further, the servo motors have associated therewith either encoders for position servo or means to determine the back electromotive force (EMF) of the motor for velocity servo. Each encoder is in bus communication with the motor controller.

The motor controller is also capable of performing background function relating to other mail process system function. As a result, the motor controller is in bus communication with other mail process system micro-controllers.

The motor controller microprocessor is programmed to perform a control cycle during which a particular time period T is allotted to each motor control function. For example, motor servo information is received in a scheduled 40 microsecond (usec) interval. All motor control functions are performed every cycle. By programming the motor controller microprocessor, microprocessor loading can be appropriately managed to facilitate expanded system control.

Upon start-up of the motor controller system, the motor determines which motor driven mechanism are present. Should the controller determine that a particular motor driven mechanism is absent, the motor controller simply reallocates the corresponding processor time, for example, to a background function. Alternatively, the motor controller system can be instructed not to enable a desired motor driven mechanism. Again, the motor controller reallocates system processor time.

Other advantages and benefits of the present invention will be apparent to one skilled in the art upon a reading of the following detailed non-limiting description of an example thereof given with reference to the accompanying drawings, in which:-

Fig. 1 is a schematic diagram of a mail processing system particularly suited to the present invention.

Fig. 2 is a schematic diagram of a motor controller system configuration in accordance with a preferred embodiment of the present invention.

Fig. 3 is a motor controller software hierarchy diagram in accordance with the present invention.

Fig. 4 is a motor controller data flow diagram in accordance with the present invention.

Fig. 5 is a schematic diagram of the motor controller mircoprocessor loading in accordance with the present invention.

In the drawings, like parts bear like reference numerals.

The present invention provides a system controller uniquely configured for application to high speed mail processing systems. Among other advantages, a principal advantage of the controller particularly disclosed herein is that it offers substantial flexibility in configuring a mail processing system. That is, the system controller enables the mail processing system to have an open architecture permitting the inclusion of additional processing stations as subsequently desired without revisiting the system controller or its programming. Alternatively, the motor controller can selectively enable subsystem of the mail processing system to create a matrix of mail processing system operating modes.

Referring to Fig. 1, in the most preferred embodiment, the system controller operates on a mail processing system, generally indicated as 11, which is comprised of a plurality of modules under the control and influence of the system controller, generally indicated as 13. The individual modules are a envelope feeder module 15, a singular module 17, a sealer transport module 19 which includes a sealer module 21, and what is here referred to as a integrated module 23. The integrated module is comprised of a scale module 25, a meter module 27, a inker module 29, a tape module 31, a transport module 33 and a platen module 35. The integrated module is so referred to because the individual modules are mounted in a single housing, collectively hereafter referred to also as a mailing machine 23. Each module includes the appropriate mechanism to perform a mail processing function.

Generally, the feeder module 15 receives a envelope stack 36 and, in the preferred embodiment, includes suitable mechanisms to shingle the bottom portion of the mail stack 36. The singulator 17 is charged with the function of extracting a bottom most envelope 38 from the now partially shingled envelope stack 36 in a seriatim manner and delivering the envelope 38 to the sealer transport module 19. The sealer transport module 19 is charged with the function of traversing the envelope 38 across the sealer module 21. The sealer transport module 19 is a smart module having the capability of determining the sealing state of the envelope 38. The sealer transport module 19 includes a diverter module 40 for sensing and responding to the seal state of an envelope such that in an operative mode pre-sealed envelope 38 can be distinguished from unsealed envelopes 38 such that only unsealed envelopes 38 are subject to sealing by the sealer module 21. The sealer transport module 19 also serves up the envelope 38 to the transport module 33 of the integrated module 23.

As aforenoted, the integrated module 23 is comprised of a scale module 25, a meter module 27, an inker module 29, a tape module 31, a transport module 33 and a platen module 35. The mailing machine transport module 33 receives the envelope 38 from the feeder transport 19 and delivers the envelope to the scale 25. The scale module 25 is charged with the function of weighing the envelope 38 and reporting the

appropriate postage value as a function of the weight det rmined to the postage meter module 27 mounted to the mailing machine 23. The indicia printing method employed in the preferred mailing system is referred to in the art as flat bed indicia printing. In accordance therewith, as the envelope 38 rests upon the scale, subsequent to being weighed, the postage meter module 27 print elements are set to the appropriate value as a function of envelope 38 weight. The inker module 29 is then charged with the function of inking the indicia of the meter module 27. Subsequent to inking of the postage meter module print elements, the platen module 35 is charged with the function of bringing the envelope 38 into printing contact with the print elements of the postage meter module 27. After the envelope 38 has been imprinted by the postage meter module 27, the transport module 33 resumes control over the envelope 38 and ejects the envelope 38 from the mailing machine 23.

Referring to Fig. 2, the controller system, generally indicated as 13, includes a programmable microprocessor motor controller 50 and a programmable microprocessor sensor controller 52. The motor controller 50 and sensor controller 52 are in direct parallel communication. Generally, the sensor controller 52 is programmed to poll each of a plurality of sensors and store the sensor in formation until called for by the motor controller 52.

A sensor bus 54 communicates the sensor controller 52 with a plurality of sensors and sensor banks. For example, the sensor controller 52 is in bus 54 communication with a plurality of sensors and sensor banks associated with the feeder section modules 15, 17 and 19, such as, optical sensors 56 associated with a water system for the sealer module 21, Hall effect sensors 58 associated with the singulator module 17 for determining the thickness of a envelope 38, an optical sensor array 60 for determining the flap configuration of an unsealed envelope 38 associated with the sealer module 21, mail flow optical sensors 62 associated with the respective feeder section modules 15, 17 and 19 for sensing the time-position of the envelope 38 relative to the respective feeder section modules 15, 17 and 19.

Further, the sensor controller 52 is in bus 54 communication with a plurality of sensors and sensor banks associated with the integrated module 23, such as, optical sensors 64 associated with the tape input to the tape module 31 and optical sensors 66 associated with the tape exit from the tape module 31, optical and Hall effect sensors 68 associated with the tape module 31 motor drive system and meter module 27 loading drive system, Hall effect sensors 70 associated with the platen module 35 drive system, and optical sensors 72 associated with the integrated module 35 for sensing the time-position of the envelope 38 within the integrated module 35.

It should be understood that suitable module assemblies acting under the motor influences is a matter of design choice. It should be further understood that the motor controller systems 13 will function cooperatively with any suitable mechanism system. The mechanism system here generally described is used for the purpose of illustration and sets forth the most preferred environment for the subject invention.

The motor controller 50 communicates through a first bus 74 with a first motor driver board 76. The driver board 76 may be located within the integrated module 23. Alternatively, the feeder section modules 15, 17 and 19 are mounted in a single housing also housing the driver board 76. The driver board 76 in turn is in respective bus 78 communication with a plurality of motors associated with a respective feeder section modules 15, 17 and 19, such as, motor 80 associated with the feeder module 15, motors 82 and 83 associated with the singulator module 17, motor 84 associated with the sealer transport module 19, motors 86 and 87 associated with the sealer module 21, and a solenoid motor 88 associated with the diverter module 40.

The motor controller 50 also communicates through a second bus 90 with a second motor driver board 92. The driver board 92, in turn, is in respective bus 94 communication with a plurality of motors associated with the modules 25, 27, 29, 31, 33 and 35 of the integrated module 23. For example, the driver board 92 through bus 94 communicated with motors 96 and 97 associated with the transport module 33, a motor 98 associated with the inker module 29, a motor 100 associated with the platen module 35, motors 102 and 103 associated with the tape/meter modules 29 and 31, and motor 104 associated with the tape module 29. It should be noted that a single driver board may be employed.

A plurality of the motors may include encoding apparatus enabling the respective motors to be under position servo-control of the motor controller 50, for example, motors 83, 84, 86, 96, 98, 100, 102, 103 and 106. An idler encoder mechanism 106 here associated with the sealer transport module 19 is included to provide true speed data for a traversing envelope 38 to the motor controller 50. The respective motor encoders are in bus 108 communication with the motor controller 50. The motor controller 50 can also communicate with ancillary and/or auxiliary system, such as, the meter module 27 and the scale module 25.

In the most preferred embodiment, the motor driver boards 76 and 96 are comprised of a plurality of channels. Each channel is associated with a respective motor and includes a conventional H-bridge amplifier responsive to a pulse width modulated signal generated by the motor controller 50. Any of the

desired motors may be subject to position servo-control, in a manner to be described subsequently, and/or velocity servo-control. With respect to any motor chosen for velocity servo-control, the respective motor driver boards 76 or 92 channel further includes a conventional EMF (Electro Motive Force) circuit for deriving the back EMF of the respective motor and communicating the back EMF to the motor controller 50 through the respective bus 94 or 90 or from which velocity information is obtained.

Referring more particularly to Figs. 3 and 4, a suitable motor controller 50 software interfaces, generally indicated as 120, is configured modularly. The software includes a 500 µsec interrupt module 122 having sub-modules for generating motor PWM'S, module 124, reading encoders and back EMF's, module 126, and reading sensor data from the sensor controller 52, module 128. The software further includes a communications module 130, position servo-control module 132, velocity servo-control module 134, a ancillary communication module 136, a scheduler module 138, a velocity profile generating module 139 and a diagnostic module 140. The ancillary communication module 136 can drive communication between the motor controller 50 and peripheral devices.

The scheduler module 138 is comprised of three sub-modules; a mode selection module 142, a mail flow scheduler module 144 and a print scheduler module 146. The mode selection module 142 will control the operation modes of the motor controller, i. e., communications, mail flow and printer schedulers modules. The mail flow module 144 will schedule any events relating to mail flow and the print scheduler module will handle scheduling all events relating to postage printing on the envelope 18.

Referring to Fig. 4, the data flow is such that the interrupt module 122 receives data from the encoder bus 108 and sensor bus 54 and motor servo modules 132 and 134. The interrupt module 122 also transmits data to the motor driver boards 76 and 92, profile generations module 139, motor servo modules 132 and 134, and a subroutine 150 which generates servo commands. Subroutine 150 is a subroutine of module 134 and is intended to configure tracking motors such as motor 86. The scheduler module 138 receives data from the interrupt module 122 and the communication modules 130 and 136. The scheduler module 138 transmits data to the profile generation module 139, command generation module subroutine 150, communication modules 130 and 136, and to the system solenoids 88 and 96. The communication modules 130 and 136 transmit and receive from the appropriate communication bus.

Generally, the motor control system 13 is responsible for the activation and control of all motors and assemblies associated with the system modules. While mail processing includes the control of transport motors in the feeder, sealer, and integrated modules, mail processing may also include operator selectable functions. For example, in accordance with the mail processing system 11, the operation options are set forth in Table 2.

TABLE 2

MAIL PROCESSING OPERATING MODE MATRIX			
	PRINTING	SEALING	WEIGHING
FLOW ONLY	OFF	OFF	OFF
WEIGHT ONLY	OFF	OFF	ON
SEAL ONLY	OFF	ON	OFF
NO PRINT	OFF	ON	ON
PRINT ONLY	ON	OFF	OFF
NO SEAL	ON	OFF	ON
NO WEIGHT	ON	ON	OFF
FULL FUNCTION	ON	ON	ON

Referring to the motor controller 50 central processor unit (CPU) loading is managed by programming the motor control 50 to sequentially perform a control cycle every 1 millisecond as shown in Fig. 5. It is appreciated that the cycle time can be adjusted to suit system requirements. Each control cycle is divided into discrete time periods T during which control functions are performed as noted in Table 1 illustrated in Fig. 5. The sequence of actions taken during each 1 millisecond control cycle, listed below, reads from right to left in Fig. 5:-

TABLE 1
TIME CYCLE LOADING OF MOTOR CONTROLLER

Time	Priority	Function
TI	1	500µsec Timer Interrupt/ Read all encoders/ Write motor configurations
T2	1	Generate command routine for motor 86
T3	3	Execute position servo control routine for motor 86
T4	2	Enter communication mode with ancillary micro systems
T5	3	Execute velocity servo control routine for motors 82
T6	3	Execute position servo control routine for motors 83
T7	3	Execute velocity servo control routine for 87
T8	3	Execute position servo control routine for motor 84
T9	3	Execute position servo control routine for motor 98
T10	2	Enter communication mode with ancillary micro-systems
T11	3	Execute velocity servo control routine for motor 100
T12	3	Execute velocity servo control routine for motor 96
T13	4	Read all sensor inputs
T14	1	500µsec Timer Interrupt/ Read all encoders/ Write motor configurations
T15	3	Generate command routine for motor 86
T16	2	Enter communication mode with ancillary micro systems

T17	3	Execute position servo-control routine for motor 86
T18	4	Reserved for auxiliary micro-system bus communication routine
T19	4	Enter Scheduler routine
T20	2	Enter communication mode with ancillary micro systems
T21	4	Execute motor profile generation routine
T22	5	Execute Run-Diagnostic routine
T23	5	Run background operation

During each control period the specified control function is performed and is prioritized. The routines range from priorities 1 to 5, priority 1 being the highest priority. In the procedure in accordance with Table 1, if at any point a higher priority function requires additional processor time, the required time is appropriated from the lowest remaining priority function. For example time may be appropriated from time interval 22 such that Run-Diagnostics are not performed in the particular cycle.

It can now be appreciated by one skilled in the art, that the present invention as described herein offers a valuable system controller for application to high speed mail processing systems and allows for substantial flexibility in the configuring of a mail processing system. It is understood that the aforedescribed detailed description represents the preferred embodiment of the invention in the most preferred system environment and that the described motor control system may be varied to most suitably accommodate the application environment. As a result, the preferred embodiment of the present invention should not be taken as limiting. The reader is advised that a concurrently-filed Application, U.S. Serial No. 281354, (Reference E229 2) claims other aspects of the system desribed herein.

Claims

1. A motor controller system for controlling the respective motors of a plurality of cooperative apparatus units associated with an article processing system, said article processing system being arranged to perform a plurality of functions upon an article traversing said article processing system, the motor controller system comprising:-

a motor driver board having a plurality of input channels and a plurality of respective output channels;

said motors being in line communication with a respective one of said output channels of said motor driver board;

a programmable microprocessor in bus communication with said driver board's input channels;

a plurality of sensors respectively mounted in association with each of said apparatus units and in bus communication with said programmable microprocessor, said sensors being located on said apparatus to provide such information to said microprocessor as article size, position and velocity information and to provide apparatus operation information; and,

said microprocessor being programmed such that a control cycle is performed at a desired frequency, each control cycle being divided into discrete time intervals during some of which said microprocessor transmits

motor control command information to said driver board for respective motors and during other of said time intervals said microprocessor reads information from said sensors.

2. A system as claimed in claim 1 wherein said driver board further includes means associated with desired ones of said driver board channels for determining the EMF of a respective motor, said means being in informing bus communication with said microprocessor.

3. A system as claimed in claim 1 or 2 further comprising encoder means responsive to the position of a plurality of said respective ones of said motors for informing said microprocessor of said respective motor position, said encoder means being in bus communication with said microprocessor.

4. A system as claimed in any of claims 1 to 3 wherein said microprocessor is further programmed to further include a plurality of cycle time intervals to process said EMF information of said respective motors and generate and send new motor servo commands for said respective motors during said next motor command transmission interval.

5. A system as claimed in any of claims 1 to 3 wherein said microprocessor is further programmed to further include a plurality of cycle time intervals to process said encoder information of said respective motors and generate and send new motor servo commands for said respective motors during said next motor command transmission interval.

6. A motor controller system for controlling the respective motors of a plurality of cooperative apparatus units associated with a mail processing system, said mail processing system being arranged for performing a plurality of functions upon a mailpiece traversing said mail processing system, the motor controller system comprising:

a motor driver board having a plurality of input channels and a plurality of respective output channels;

said motors being in line communication with a respective one of said output channels of said motor driver board;

a programmable microprocessor in bus communication with said driver board's input channels;

a plurality of sensors respectively mounted to each of said apparatus units and in bus communication with said programmable microprocessor, said sensors being located on said apparatus to provide such information to said microprocessor as mail size, position and velocity information and to provide apparatus unit operation information;

said microprocessor being programmed such that a control cycle is performed at a desired frequency, each control cycle being divided into discrete time intervals during some of which said microprocessor transmits motor control command information to said driver board for respective motors and during other of said time intervals said microprocessor reads information from said sensors; and, said time intervals allocated for control command information and for reading sensor information occupying less time than the total time available during each cycle.

7. A system as claimed in claim 6 further comprising motor velocity program means for generating a velocity profile for each of said respective motors during another one of said time intervals.

8. A system as claimed in claim 6 or 7, wherein each control cycle time interval is dedicated to the microprocessor performing a particular function which is repeated during successive control cycles.

9. A high-speed mail processing system comprising:

(a) apparatus for processing mail pieces in seriatim, said apparatus including at least a plurality of active means selected from among the following means:

feeder means, singulator means, sealer means, scale means, printing means, postage accounting means, and transport means;

(b) each of said active means having motor means for actuating same and sensing means for detecting mailpiece events as mailpieces are processed by said active means and upon detection generating sense signals;

(c) a controller for controlling operation of said apparatus for processing, said controller having programmable microprocessor means and being connected by way of communication lines to each of said active means which is active in said apparatus for processing, said controller being programmed to execute repeatedly a control cycle of operations in which, during each cycle, the controller communicates with each of the active means to determine its status by receiving its sense signals and to issue commands to the motor means of the active means in response to said received sense signals in accordance with a program controlling the microprocessor means.

10. A system as claimed in claim 9, wherein each control cycle is divided up into discrete time periods allocated to performing particular functions associated with the active processing apparatus means.

11. A system as claimed in claim 10, wherein at least one of said time periods is allocated for performing background processing.

12. A system as claimed in claim 10, wherein at least one of said time periods is not allocated but is

free for performing functions on processing means subsequently added to the system.

13. A motor controller system for controlling the respective motors of a plurality of cooperative apparatus units associated with an article processing system, said article processing system being arranged for performing a plurality of functions upon an article traversing said article processing system, each apparatus unit having sensors associated therewith and located to provide information concerning articles and to provide operation information, said motor controller system comprising:

(a) motor driver means having input and output channels, said motors being in communication with an output channel of said motor driver means;

(b) programmable microprocessor means in communication with said motor driver means' input channels and with said sensors; and

(c) said microprocessor means being programmed:

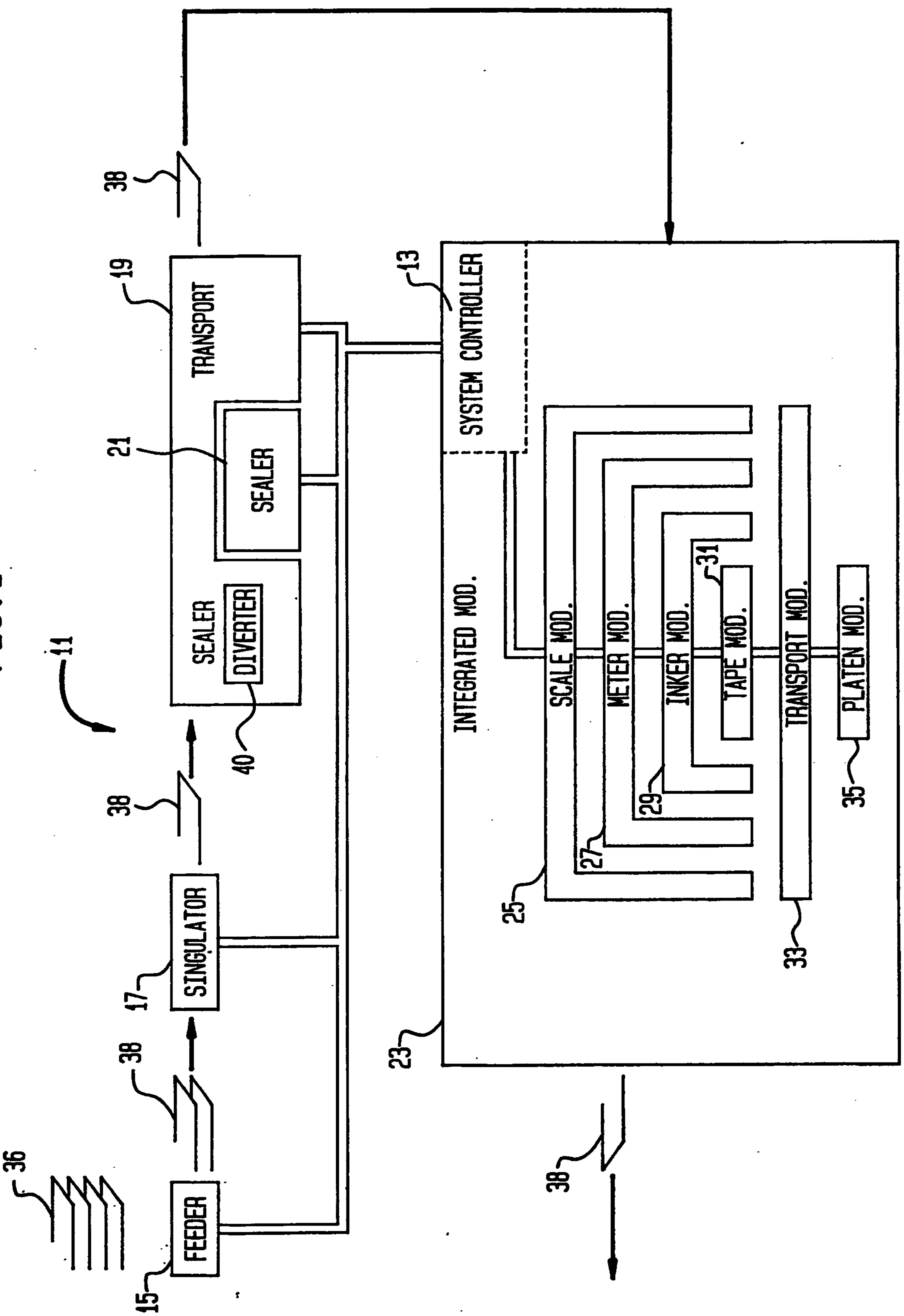
(i) to perform a control cycle at a desired frequency, each ontrol cycle being divided into discrete time intervals,

(ii)during corresponding time intervals of each cycle, to transmit motor control command information to said driver means for respective motors, and

(iii) during corresponding others of said time intervals, to read information from said sensors.

14. A system as claimed in claim 13, wherein said motors are controlled solely by information transmitted thereto along the output channel from the driver means.

FIG. 1


11
FEEDER
15
36
38
SINGULATOR
17
SEALER
DIVERTER
40
SEALER
21
TRANSPORT
19
SYSTEM CONTROLLER
13
INTEGRATED MOD.
SCALE MOD.
METER MOD.
INKER MOD.
TAPE MOD.
31
TRANSPORT MOD.
PLATEN MOD.
25
27
29
33
35
23

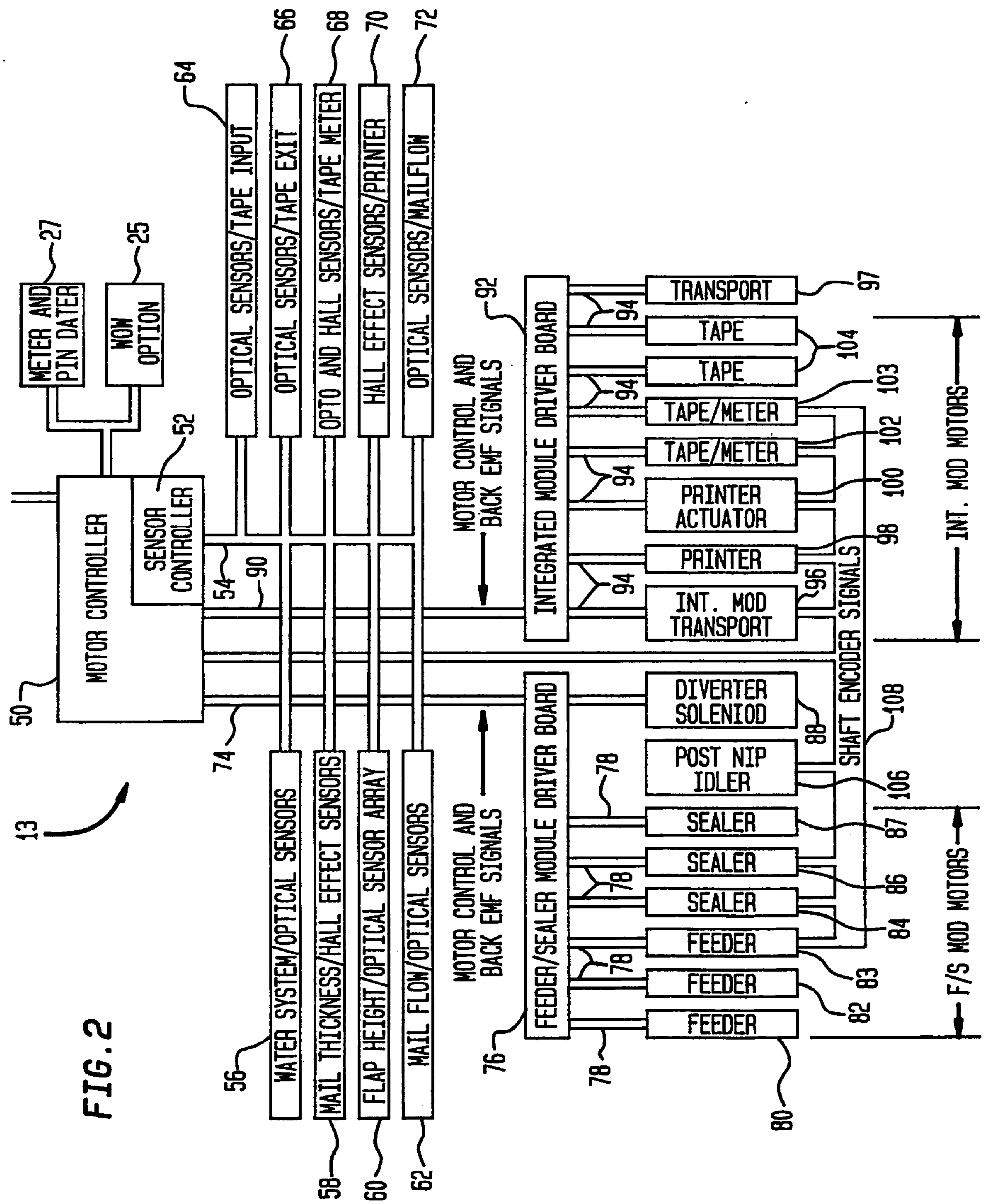

13
METER AND PIN DATER
27
WOW OPTION
25
MOTOR CONTROLLER
50
SENSOR CONTROLLER
52
54
90
74
OPTICAL SENSORS/TAPE INPUT
64
OPTICAL SENSORS/TAPE EXIT
66
OPTO AND HALL SENSORS/TAPE METER
68
HALL EFFECT SENSORS/PRINTER
70
OPTICAL SENSORS/MAILFLOW
72
WATER SYSTEM/OPTICAL SENSORS
56
MAIL THICKNESS/HALL EFFECT SENSORS
58
FLAP HEIGHT/OPTICAL SENSOR ARRAY
60
MAIL FLOW/OPTICAL SENSORS
62
MOTOR CONTROL AND BACK EMF SIGNALS
INTEGRATED MODULE DRIVER BOARD
92
94
TRANSPORT
97
TAPE
TAPE
104
TAPE/METER
103
TAPE/METER
102
PRINTER ACTUATOR
100
PRINTER
98
INT. MOD TRANSPORT
96
INT. MOD MOTORS
SHAFT ENCODER SIGNALS
108
MOTOR CONTROL AND BACK EMF SIGNALS
FEEDER/SEALER MODULE DRIVER BOARD
76
78
DIVERTER SOLENIOD
88
POST NIP IDLER
106
SEALER
87
SEALER
86
SEALER
84
FEEDER
83
FEEDER
82
FEEDER
80
F/S MOD MOTORS

FIG.2

FIG.3

MMP MOTOR CONTROLLER SOFTWARE HIERARCHY

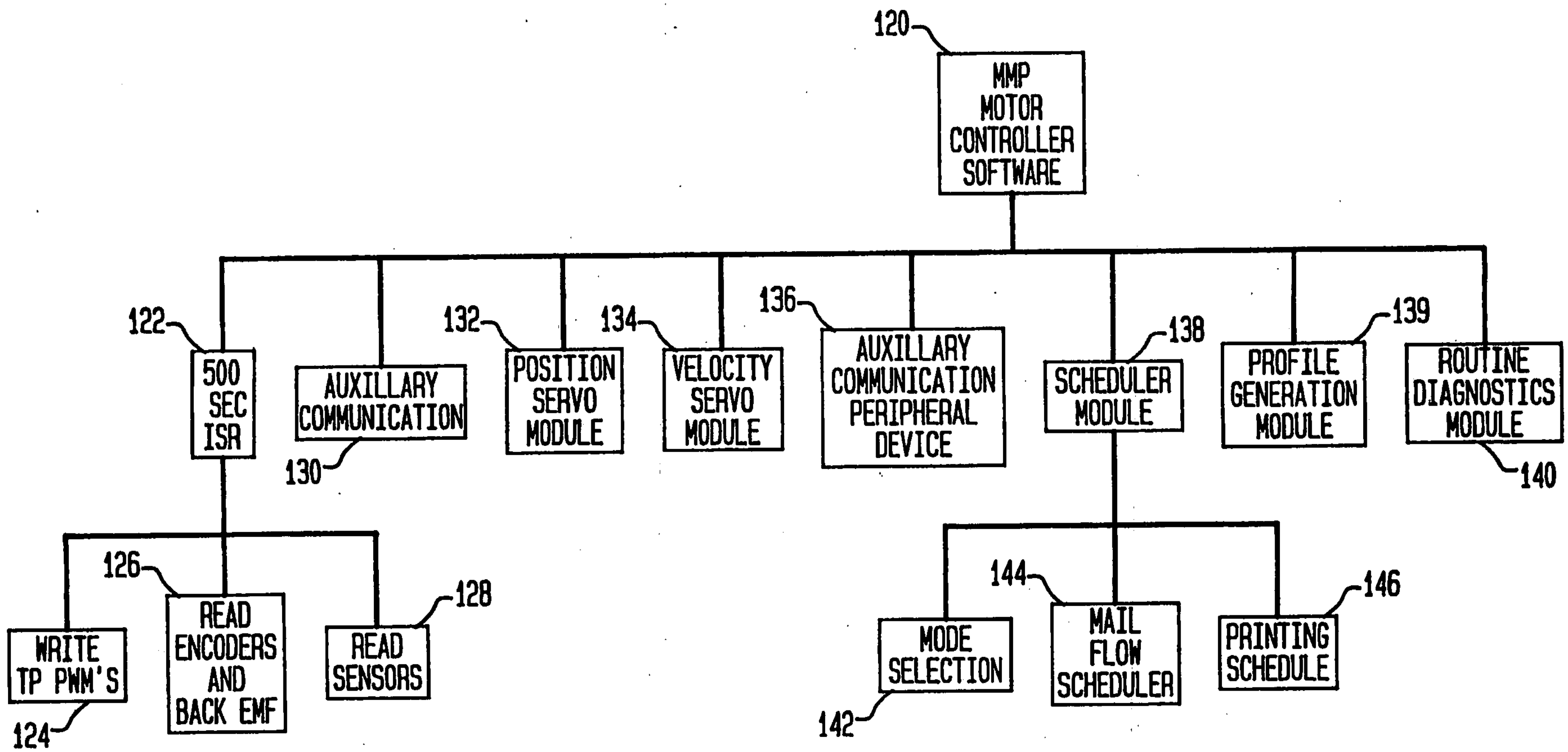


FIG. 4

MMP MOTOR CONTROLLER DATA FLOW

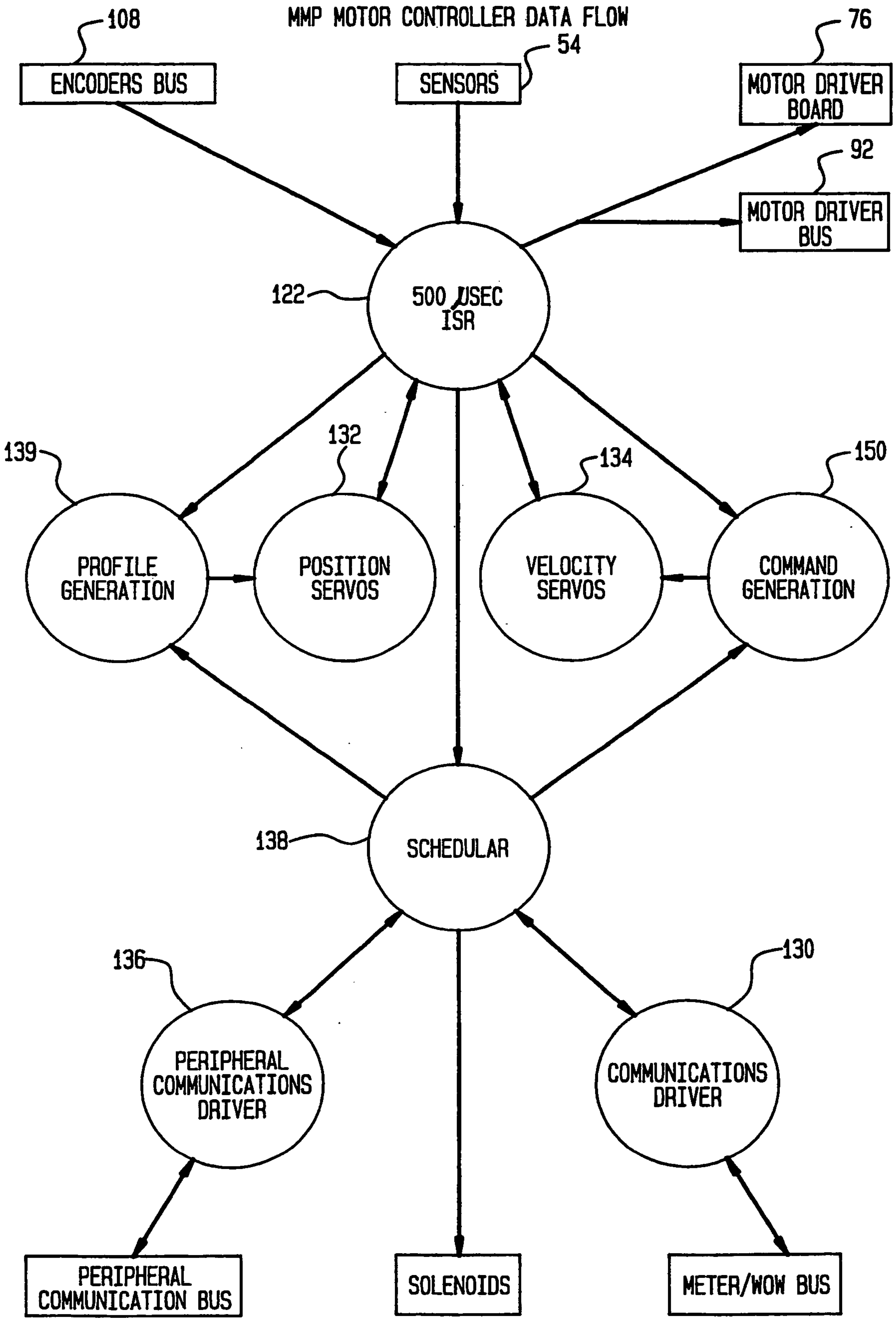
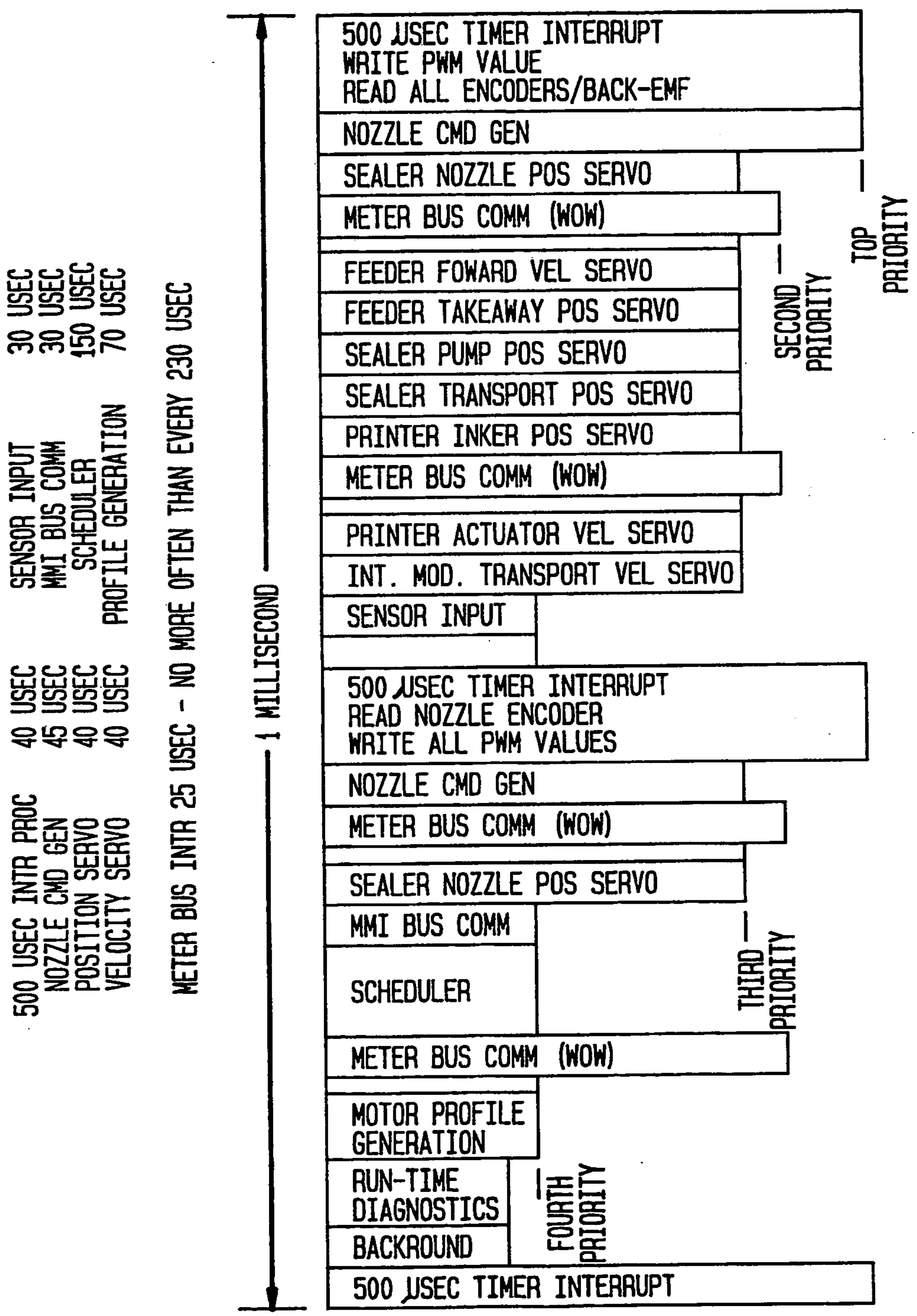


FIG.5


500 µSEC TIMER INTERRUPT
WRITE PWM VALUE
READ ALL ENCODERS/BACK-EMF
NOZZLE CMD GEN
SEALER NOZZLE POS SERVO
METER BUS COMM (WOW)
FEEDER FOWARD VEL SERVO
FEEDER TAKEAWAY POS SERVO
SEALER PUMP POS SERVO
SEALER TRANSPORT POS SERVO
PRINTER INKER POS SERVO
METER BUS COMM (WOW)
PRINTER ACTUATOR VEL SERVO
INT. MOD. TRANSPORT VEL SERVO
SENSOR INPUT
500 µSEC TIMER INTERRUPT
READ NOZZLE ENCODER
WRITE ALL PWM VALUES
NOZZLE CMD GEN
METER BUS COMM (WOW)
SEALER NOZZLE POS SERVO
MMI BUS COMM
SCHEDULER
METER BUS COMM (WOW)
MOTOR PROFILE GENERATION
RUN-TIME DIAGNOSTICS
BACKROUND
500 µSEC TIMER INTERRUPT
TOP PRIORITY
SECOND PRIORITY
THIRD PRIORITY
FOURTH PRIORITY
1 MILLISECOND
500 USEC INTR PROC 40 USEC
NOZZLE CMD GEN 45 USEC
POSITION SERVO 40 USEC
VELOCITY SERVO 40 USEC
SENSOR INPUT 30 USEC
MMI BUS COMM 30 USEC
SCHEDULER 150 USEC
PROFILE GENERATION 70 USEC
METER BUS INTR 25 USEC - NO MORE OFTEN THAN EVERY 230 USEC